



Declaration for Translation of Priority Document

I, the undersigned Kazuhide Okada

residing at Osaka, Japan

do solemnly and sincerely declare that I am well acquainted with the Japanese language and the English language and that the attached English translation of a certified copy of JP2000-397329 filed on December 27, 2000 is a true, correct and faithful translation to the best of my knowledge and belief from the Japanese language into the English language.

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[Title of the Invention] A CIRCUIT BOARD AND ITS MANUFACTURE METHOD

[Scope of Claims for Patent]

5 [Claim 1] A circuit board comprising: at least two wiring layers; an insulator layer for electrically insulating said wiring layers; and a Via provided in said insulator layer to electrically connect said wiring layers each other, characterized in that:

10 a protective agent is dispersed and placed in mottle-like on an interface between said via and said wiring layer to protect said wiring layers, while each dimension of said interface regions where said protective agent does not exist is set to such a dimension that a plurality of conductive powders
15 constituting said via may abutted on said wiring layer; and the plurality of said conductive powders and said wiring layers are abutted each other in each said interface regions where said protective agent does not exist so as to electrically connect.

20 [Claim 2] The circuit board according to Claim 1, characterized in that

 said protective agent is provided on a surface of said wiring layer.

 [Claim 3] The circuit board according to Claim 1 or 2, characterized in that

25 said protective agent contains zinc and nickel.

 [Claim 4] The circuit board according to any of Claims 1 to 3, characterized in that

 said protective agent has a function to enhance an adhesion strength between said via and said wiring layers.

30 [Claim 5] The circuit board according to Claim 4, characterized in that

 said protective agent contains a chromate or a silane coupling agent.

[Claim 6] The circuit board according to any of Claims 1 to 5, characterized in that

said conductive powders and said wiring layers are connected each other by metal adhesion.

5 [Claim 7] The circuit board according to any of Claims 1 to 6, characterized in that

a region where connection by metal fusion occurs between said wiring layers and said conductive powders is set at 0.03% or more than a cross-sectional area of said via.

10 [Claim 8] The circuit board according to any of Claims 1 to 7, characterized in that

said via is a resin composition containing a conductive material.

[Claim 9] The circuit board according to any of Claims 1 to 15 8, characterized in that

said conductive powders contained in said via are the same conductor contained in said wiring layers.

[Claim 10] The circuit board according to any of Claims 1 to 9, characterized in that

20 said wiring layers contain copper.

[Claim 11] The circuit board according to any of Claims 1 to 10, characterized in that

said conductive powders contain at least one of copper and silver.

25 [Claim 12] The circuit board according to any of Claims 1 to 11, characterized in that

said insulator layer is composed of a polymer film.

[Claim 13] A method for manufacturing a circuit board characterized by comprising the steps of:

30 forming a through hole on an insulator layer and then filling said through hole with a conductive paste;

dispersing to form a protective agent in mottle-like on an adhesion surface of a conductor foil which provides a wiring

layer, and dispersing to form each dimension of adhesion surface regions where said protective agent does not exist in a state that the plurality of said conductive powders constituting said conductive paste is set as a size to be capable of contacting
5 on the said wiring layer;

bonding said conductor foil to said insulator layer; and electrically and physically connecting said conductor foil and said conductive paste by contacting the plurality of said conductive powders and said conductor foil each other by means
10 of heating and pressurizing said insulator layer.

[Claim 14] The method for manufacturing the circuit board according to Claim 13, characterized in that

said protective agent is stored and placed into a minute pit in said adhesion surface by connecting an adhesive surface of
15 said conductor foil on a liquid containing the protective agent, while a storage amount of said protective agent for said minute pit is controlled by adjusting an contacting time of said liquid containing the protective agent, thereby setting each dimension of the adhesion surface regions where said protective
20 agent does not exist.

[Claim 15] The method for manufacturing the circuit board according to Claim 13, characterized in that

said protective agent is stored and placed into the minute recess in the adhesion surface by connecting the adhesion of
25 said conductor foil on the liquid containing the protective agent, while the storage amount of said protective agent for said minute pit is adjusted by adjusting a protective agent containing amount of said liquid containing the protective agent, thereby setting each dimension of the adhesion surface regions
30 where said protective agent does not exist.

[Claim 16] The method for manufacturing the circuit board according to Claim 13, characterized in that

a layer containing said protective agent is formed on the

adhesion surface of said conductor foil, and then the protective agent layer is polished until a top portion of a minute protrusion on said adhesion surface may be exposed, while a exposed amount of said top portion is adjusted by a polishing time, thereby setting each dimension of the adhesion surface regions where said protective agent does not exist.

[Detailed Description of the Invention]

[0001]

[Technical Field Pertinent to the Invention]

10 The present invention relates to a circuit board used in various electronic apparatuses.

[0002]

[Prior Art]

For a recent trend for a size reduction and a lighter weight of electronic apparatuses and a higher functionality thereof, it has been required that a circuit board is provided with smaller in size, lighter in weight, and higher signal processing capability as well as higher mounting density. The circuit board that can meet these requirements needs to be implemented a multi-layer technology, the one for decreasing the diameter of a Via hole, and finer patterning of the circuits. Therefore, it is becoming more and more difficult to satisfy the requirements with a circuit board on which interlayer electrical connections are implemented by the conventional through-hole construction.

[0003]

To meet those desires, new circuit boards have been developed. As the materials of the circuit board an organic fiber-based materials and films has been developed in addition to the conventional glass-based materials.

[0004]

As a typical example it is known that a circuit board employs a full-IVH construction in which the interlayer connection is

secured by conductive paste (Japanese Patent Publication No. 2601128). This circuit board uses a composite material such as aramid-epoxy resin to form insulator layers thereof, to have such advantages as a smaller coefficient of thermal expansion, a lower dielectric constant, and a lighter weight, thus finding wide application in a variety of electronic apparatuses.

[0005]

[Problems to be Solved by the Invention]

To further improve the functionality of the circuit board, however, it is necessary to secure the stability in its connection resistance for a longer term.

[0006]

It is an object of the present invention to secure a long term stability of the connection resistance.

[0007]

[Means for Solving the problems]

For the purpose of achieving the above mentioned object, the present invention provides a circuit board comprising: at least two wiring layers; an insulator layer for electrically insulating the above mentioned wiring layers; and a Via provided in the above mentioned insulator layer to electrically connect the above mentioned wiring layers each other, wherein a protective agent is dispersed and placed in mottle-like on an interface between the above mentioned Via and the above mentioned wiring layer to protect the above mentioned wiring layers, while each dimension of the above mentioned interface regions where the above mentioned protective agent does not exist is set to such a dimension that a plurality of conductive powders constituting the above mentioned Via may connect to the above mentioned wiring layer, and the plurality of the above mentioned conductive powders and the above mentioned wiring layers are abutted each other at the respective interface regions mentioned above where the above mentioned protective agent does not exist in order

to electrically connect, thus achieving the above mentioned object.

[0008]

[Embodiments of the Invention]

5 The invention as recited in Claim 1 of the present invention is a circuit board comprising: at least two wiring layers; an insulator layer for electrically insulating the above mentioned wiring layers; and a Via provided in the above mentioned insulator layer to electrically connect the above mentioned wiring layers
10 each other, characterized in that a protective agent is dispersed and placed in mottle-like on an interface between the above mentioned Via and the above mentioned wiring layer to protect the above mentioned wiring layers, while each dimension of the above mentioned interface regions where the above mentioned
15 protective agent does not exist is set to such a dimension that a plurality of conductive powders constituting the above mentioned Via may abutted on the above mentioned wiring layer, and the plurality of the above mentioned conductive powders and the above mentioned wiring layers are abutted each other in at
20 the respective interface regions mentioned above where the above mentioned protective agent does not exist in order to electrically connect. With this structure, the following operations are made possible. That is, in a region where the protective agent does not exist in an adhering region between
25 the wiring layer and the Via, the conductive powder constituting the Via and the wiring layer are interconnected electrically. Moreover, in a region where the protective agent does not exist, since the plurality of the conductive powders abut on the wiring layer to be electrically interconnected, the electrical
30 connection is further strengthened, thereby ensuring the preservation stability for a long period and reliability of the connection resistance. Further, in a region where the protective agent exists, the wiring layer and the Via can be

prevented from invasion of water or oxidation by means of protection of a protecting layer.

[0009]

As recited in Claim 2, in this case, it is preferable that
5 the protecting layer is provided on the surface of the wiring layer. Then, it is relatively easy to provide the protecting layer on the interface.

[0010]

As recited in Claim 3, the protective agent that can be used
10 in the present invention may include substance that contains, for example, zinc or nickel.

[0011]

As recited in Claim 4, further, the protective agent can be made of such a material having a function to enhance the adhesion
15 strength between the Via and the wiring layer so as to strengthen the physical adhesion between them, thus further improving the preservation stability for a long term.

[0012]

As recited in Claim 5, a substance containing a chromate or
20 a silane- coupling agent is listed as the protective agent that may improve the adhesion strength.

[0013]

As recited in Claim 6, further, when the conductive powder and the above mentioned wiring layer are connected each other
25 by metal adhesion, a corresponding metallic bond is produced between them, whereby a strong conductive path is formed to obtain good electrical connection. As a result, the prolonged retention stability and reliability of the connection resistance are further improved.

30 [0014]

Further, As recited in Claim 7, if the size of the region where metal adhesion is produced between the wiring layer and the Via is made to be more than 0.03% of the cross-sectional area of

the Via, the stability and reliability of the connection resistance for a long term can be much more improved.

[0015]

Further, As recited in Claim 8, if the via is made of a resin composition containing a conductor, it can be compressed by heating it under pressure. As a result the conductive path is made stronger as the occupation ratio of the conductor component in the via is increased.

[0016]

As recited in Claim 9, further, if the conductor contained in the via is made of the same material as that of the wiring layer, the metallic bond or adhesion can be generated easily.

[0017]

In the present invention, it is preferable that the conductor consisting of the wiring layers contains copper as recited in Claim 10, it is also preferable that the conductive powders contained in the via contain one of copper and silver at least according to Claim 11, and it is more preferable that the insulator layer is composed of a polymer film according to Claim 12.

[0018]

As recited in Claim 13, the circuit board according to any of Claims 1 to 12 can be manufactured by a method including the steps of: forming a through hole to an insulator layer and then filling the through hole with a conductive paste; dispersing to form a protective agent in mottle-like and in a state that each dimension of adhesion surface regions where the protective agent does not exist is set so that the plurality of the conductive powders contained in the conductive paste is set a size to be capable of contacting on the wiring on an adhesion surface of a conductor foil to be a wiring layer; bonding the conductor foil to the insulator layer; and electrically and physically jointing the conductor foil and the conductive paste by contacting the plurality of the conductive powders and the

conductor foil each other by means of heating and pressurizing the insulator layer.

[0019]

Further with respect to a method of setting up each dimension
5 of the adhesion surface region where the protective agent does
not exist, as recited in Claim 14, the protective agent is stored
and placed into a minute pit portion in the adhesion surface
by abutting the adhesion surface of the conductor foil on a liquid
containing protective agent, while a storage amount of the
10 protective agent to the minute pit portion is controlled by
adjusting contacting time of the liquid containing protective
agent, thereby setting up each dimension of the adhesion surface
regions where the protective agent does not exist is able to
be done.

15 [0020]

With respect to another method of setting up each dimension
of the adhesion surface region where the protective agent does
not exist, as recited in Claim 15, the protective agent is stored
and placed into a minute pit portion in the adhesion surface
20 by abutting the adhesion surface of the conductor foil on a liquid
containing protective agent, while a storage amount of the
protective agent to the minute pit portion is controlled by
regulating content of the protective agent in the liquid
containing protective agent, thereby setting up each dimension
25 of the adhesion surface regions where the protective agent does
not exist is able to be done.

[0021]

Further, as recited in Claim 16, a layer containing the
30 protective agent is formed on the adhesion surface of the
conductor foil, then, the protective agent layer is polished
until a extent that a top portion of minute protrusion on the
adhesion surface may be exposed, while an exposed amount of the

top portion of minute protrusion is adjusted during polishing, thereby it is made possible to set up each dimension of the adhesion surface region where the protective agent does not exist.

5 [0022]

A detailed description is given below about the preferable embodiments of the present invention with the accompanying drawings.

[0023]

10 FIG. 1 is a cross-sectional view showing a structure of a circuit board of one embodiment of the present invention. FIG. 2 is an imaginary illustration of a metal adhesion portion.

[0024]

In FIG. 1, a reference numeral 1 indicates an insulator layer, 15 a reference numeral 2 indicates a wiring layer, a reference numeral 3 indicates a via, a reference numeral 4 indicates a conductive powder, a reference numeral 5 indicates a metal adhesion portion, and a reference numeral 6 indicates a protective agent. In FIG. 2, a reference symbol 5a indicates 20 an adhesion mark and a reference symbol 5b indicates an image thereof.

[0025]

In a circuit board shown in FIG. 1, an insulator layer 1 and a wiring layer 2 are laminated alternately and interlayer 25 electrical connection is performed by a via 3.

[0026]

The circuit board has the following features. That is, a protective agent 6 for protecting the wiring layer 2 is dispersed and placed in mottle-like at least on a surface contacting via 30 (hereinafter referred to as a via contacting surface) 2a among the surfaces of the wiring layer 2. On this via contacting surface 2a, each of regions 7 where the protective agent 6 does not exist is set up as a size such that a plurality of conductive

powders 4 consisting of the via 3 can contact the surface of the wiring layer 2. the via 3 and the wiring layer 2 is connected electrically by such a structure of the wiring layer 2, wherein a plurality of the conductive powders 4 contacts the wiring layer 2 at each of the regions 7. Moreover, the conductive powders 4 and the wiring layer 2 are physically and electrically connected by metal adhesion between both of them.

[0027]

The circuit board of this embodiment can be manufactured, for example, as follows.

[0028]

First of all, as shown in FIG. 3(a), a through hole 8 is formed by laser treatment or the like to the insulator layer 1 consisting of a prepreg obtained by an aromatic polyamide non-woven fabric impregnated with a thermosetting resin such as a thermosetting epoxy resin. Then, the through hole formed 8 is filled with a conductive paste 9. On the other hand, as shown in FIG. 3(b), a protective agent 6 is dispersed and formed in mottle-like which is composed of zinc, nickel, chromate, silane coupler or the like on an adhesion surface 10a (which serves as a via contacting surface 2a) of a conductor foil 10 to be the wiring layer 2. In this step, each of the regions 7 where the protective agent 6 does not exist is set up as such a size that a plurality of the conductive powders 4 composing of the conductive paste 9 may contact the wiring layer 2.

[0029]

There are the following three methods to set up the dimension of the regions 7 as mentioned above. As the first method, as shown in FIG. 4(a), a chemical reagent containing the protective agent 6 (hereinafter referred to as a liquid containing protective agent) is prepared, to which the adhesion surface 10a (the surface adhered to the insulator layer 1 including the via 3) of the conductor foil 10 is then contacted. At this time,

the protective agent 6 is stored and placed into minute pit 11 in the adhesion surface 10a. In this step, the treatment time for which the adhesion surface 10a contact the protective agent is regulated to thereby control the amount of a liquid containing the protective agent 6 stored in the minute pit 11, thus setting up the dimension of each of the regions 7 is done.

[0030]

Also in the second method, it takes the same as the first method that the adhesion surface 10a of the conductor foil 10 is contacted to a liquid containing the protective agent to thereby store and place the protective agent 6 into the minute pit 11 in the adhesion surface 10a. In the second step, the amount of the protective agent 6 contained in a liquid containing the protective agent is regulated to thereby control the amount of the protective agent 6 stored in the minute pit 11, thus setting up the dimension of each of the regions 7 is done.

[0031]

As the third method, first a layer containing the protective agent 6 is formed on the adhesion surface 10a of the conductor foil 10. In this step, the layer containing the protective agent is formed in such a manner as to cover everywhere on the adhesion surface 10a. Then, this layer containing the protective agent is polished by etching and the like. At this time, as shown in FIG. 4(b), an extent is controlled at which the top portion 12a of each of minute protrusions 12 on the adhesion surface 10a is exposed, by regulating a amount of polishing. Thus setting up the dimension of each of the regions 7 is done.

[0032]

After the protective agent 6 is thus dispersed and formed in mottle-like on the adhesion surface 10a of the conductor foil 10, as shown in FIG. 3(c), the conductor foil 10 is adhered to the insulator layer 1. Then, the conductor foil 10 is fixed onto the insulator layer 1 by heating under pressurizing the

insulator layer 1 and the conductor foil 10 (under such conditions of (treatment conditions such as a temperature of 200°C, at a pressure of 4.9 MPa, and for one hour). In this case, further, a plurality of the conductive powders 4 is contacted to the surface of the conductor foil 10 to thereby electrically and physically interconnect the conductor foil 10 and the conductive powders 4 in the conductive paste 9 to each other. In the meantime, by the heating and pressurizing treatment, a portion of the metal adhesion 5 is formed at an adhesion interface between the conductor powders 4 and the conductor foil 10. Therefore, a metallic bond by a portion of the metal adhesion 5 gives a good conductive pass with a strong electrical connection.

[0033]

Thereafter, as shown in FIG. 3(d), the conductor foil 10 is patterned by photolithography method to form the wiring layer 2.

[0034]

Though a both-side circuit board is thus manufactured, a multiple layer circuit board with four layers, for example, is fabricated as follows. A pair of other insulator layers 1 where the through hole 8 is filled with the conductive paste 9 are prepared to then sandwich a both-side circuit board between them, then, the conductor foil 10 (having the protective agent given already) made of a copper foil or the like is laminated on both sides of the sandwiched circuit board. Further the conductor foil 10 is patterned to fabricate the four-layered circuit board after heat treatment under pressure under almost the same conditions as described above.

[0035]

FIGS. 5 to 7 are figures to show respective results analyzed on the state of the outermost surface of the copper foil used in the above-mentioned embodiment as well as comparative examples 1 and 2 by an XPS apparatus (X-ray photoelectron spectrum

analyzer), wherein zinc and nickel are used as the protective agent 6.

[0036]

FIG. 5 shows the results of the comparative example 1 where
5 analysis is carried out on the adhesion surface 10a of the
conductor foil 10 (copper foil) without surface treatment at
all by use of the protective agent 6. FIG. 6 shows the results
of the comparative example 2 where analysis is likewise carried
out on the adhesion surface 10a of the conductor foil 10 (copper
10 foil) covered everywhere by the protective agent 6 composed of
zinc and nickel. FIG. 7 shows the results of the embodiment of
the present invention where analysis is likewise carried out
on the adhesion surface 10a of the conductor foil 10 (copper
foil) on which the protective agent 6 composed of zinc and nickel
15 is dispersed and placed in mottle-like.

[0037]

In those figures, the horizontal axis shows a shift amount
and the vertical axis shows a frequency of the measurement
results. Each of the data indicates a measurement result on
20 the state of the uppermost layer of the adhesion surface 10a
shaped off at each of a minute thickness after sputtering at
an interval of 18 seconds is finished thereon. In those figures,
the lower data indicates the state of the positions closer to
the uppermost surface and the lowest data indicates that of the
25 uppermost surface.

[0038]

As it is clear in the figure only the protective agent 6 exists
on an uppermost surface of the adhesion surface 10a in the
comparative example 2 which has the conductor foil (copper foil)
30 10 covered everywhere by the protective agent 6 made of zinc
and nickel. It is also clear that only the conductor foil 10
exists on an uppermost surface of the adhesion surface 10a of
the comparative example 1 which has the conductor foil (copper

foil) 10 without any surface treatment by the protective agent 6. In contrast, it is clear that the conductor foil 10 and the protective agent 6 exists as mixture on an uppermost surface of the adhesion surface 10a of the embodiment of the present invention which has the conductor foil 10 on which the protective agent 6 is dispersed and placed in mottle-like. Symbols A, B, and C indicate the peak value of the protective agent 6 in FIG. 7.

[0039]

In the circuit board of the present invention, for example, the protective agent 6 is placed in mottle-like on the via surface 2a contacting the wiring layer 2 by reducing the quantity of the surface treatment by the protective agent 6 to the wiring layer 2 (conductor foil 10). This process causes a plurality of the conductive powders 4 to contact the wiring layer 2 and be electrically connected therewith in the region 7 where the protective agent 6 does not exist. This leads to stabilize electrical properties of the conductive path formed resultantly. Further, electrical connection is realized by metal adhesion between the wiring layer 2 and the conductive powders 4 contained in the conductive paste 9, thus further lead to secure stronger conductive path. Therefore it is achieved to preservation stability of connection resistance for a long term.

[0040]

Further, since the protective agent 6 exists at a part which is not participated in electrical connection, it is possible to obtain an effect of preventing oxidation of the surroundings of the regions forming the conductive path and penetration of water from outside to the regions forming the conductive path. Further, in case that a chromate or silane coupler is as the protective agent 6, it is effective for not only prevention of oxidation and water penetration and but also to enhance the

adhesion strength between the wiring layer 2 and the via 3.

[0041]

Although a copper foil is used in the embodiment here as the wiring layer 2, the present invention is not limited thereto; for example, a stainless steel, aluminum, nickel, and other metal foils well known can be used to have the same effects.

[0042]

Further, the following material is used in the embodiment as the insulator layer 1 such as a prepreg obtained by impregnating an aromatic polyamide non-woven fabric with a thermosetting epoxy resin. The present invention, however, is not limited to use thereof as the base material; for example, it may be possible to use other materials such as a glass-fabric base material, a glass non-woven fabric base material, an aramid fabric base material, an aramid non-woven fabric base material, a liquid crystal polymer non-woven fabric base material or the like. Further, the thermosetting resins that can be used in the present invention include a phenol resin, a naphthalene-based resin, a urea resin, an amino resin, an alkyd resin, a silicon resin, a furan resin, an unsaturated polyester resin, an epoxy resin, a polyurethane resin, and other well known thermosetting resins commercialized. The prepreg composing the insulator layer 1 can be given by combining any of these base materials and thermosetting resins to provide the same effects as the embodiment.

[0043]

Further, although such a prepreg is used in the embodiment as the insulator layer 1 which is obtained by impregnating the base material with a resin, the present invention is not limited thereto; for example, a polymer film may be used as the insulator layer. The polymer films that can be used may include a polyimide film, an aramid film, a liquid crystal polymer film, and other well known polymer films.

[0044]

Note here that the conductive paste 9 that can be used in the present invention is composed of at least the conductive powders 4 and a thermosetting resin. The conductive powders 4 include copper powder, silver powder, nickel powder, aluminum powder, other metal powders, and powders covered by any of these metals. The conductive powders 4 may take on such a form as a resin, flake, cube, or amorphous form. The thermosetting resins that can be used in the present invention may include a phenol-based resin, a naphthalene-based resin, a urea resin, an amino resin, an alkyd resin, a silicon resin, a furan resin, an unsaturated polyester resin, an epoxy resin, a polyurethane resin, other well known resins, and any appropriate combinations thereof. Further, an additive or solvent may be added to such a thermosetting resin for the oxidation stability and regulating viscosity of the conductive paste.

[0045]

The results of evaluation are shown in (Table 1) about connection reliability of the circuit board obtained in the embodiment 1 of the present invention as well as the comparative examples 1 and 2 carried out by (PCT test, high temperature/high humidity environment test, solder-reflow resistance test). As described above, such a circuit board is used in the comparative example 1 which has the wiring layer 2 without any surface treatment by use of the protective agent 6. Likewise, such a circuit board is used in the comparative example 2 which has the wiring layer (copper foil) 2 covered everywhere by the protective agent 6 composed of zinc and nickel.

[0046]

Note here that in the PCT test, connection resistance of a sample was determined before and after it was placed under such an environment that the temperature was 121°C, the pressure was 0.2 Mpa, and the duration was 300 hours, and each sample was

evaluated by calculating a ratio of change in the connection resistance measurements.

[0047]

In the solder reflow-resistance test, connection resistance of each sample was measured for its before and after 10 cycles of reflow processing under at a temperature of 230°C for 30 seconds as one cycle, and then each sample is evaluated by calculating a ratio of change in the connection resistance measurements.

[0048]

In the high temperature/high humidity environment test, connection resistance of each sample was measured before and after it was placed in such an environment that the temperature was 85°C, the humidity was 85%, and the duration was 168 hours, and then each sample is evaluated by calculating a ratio of change in the connection resistance measurements.

[0049]

The connection resistance was measured by the four-terminal method using a 3456A-type apparatus (made by Hewlett-Packard).

[0050]

20 [Table 1]

Sample of:	Agglutination area (in percentage with respect to cross-sectional area of via)	Test conducted	Results*
Embodiment of the present invention	0.03 -	PCT test	◎
		85°C/85%RH/168h	◎
		230°C/30sec×10cycle	◎
Comparative example 1	0.03 -	PCT test	○
		85°C/85%RH/168h	◎
		230°C/30sec×10cycle	◎
Comparative example 2	< 0.01	PCT test	△
		85°C/85%RH/168h	○
		230°C/30sec×10cycle	◎

*: ◎ indicates less than 3%, ○ indicates 3 to 5%, and △ indicates 5 to 10% as a value of the change ratio of the connection resistance.

As is clear from Table 1, it can be understood that the embodiment of the present invention provides the same initial value of the connection resistance as that of the comparative example 1 without surface treatment by use of the protective agent 6. To obtain such a stable initial value of the connection resistance, it is necessary as is clear from Table 1 to set up an area of a region caused metal adhesion between the wiring layer 2 and the conductive powders 4 at 0.03% or more of the cross-sectional area of the via 3.

[0051]

Besides the above effects, the present invention gives the following effect. That is, since a plurality of the conductive powders 4 contacts the wiring layer 2 in the region 7 where the protective agent 6 does not exist to be electrically connected, the conductive path formed therebetween is further stabilized in electrical characteristics. In addition, since the protective agent 6 is dispersed and placed in mottle-like on the via contacting surface 2a of the wiring layer 2, a portion of the metallic adhesion 5 is formed between the conductive powders 4 contained in the conductive paste 9 and the conductor (copper) in the wiring layer 2, thus further the stronger conductive path is formed. Those factors contribute to preservation for a long term and therefore stabilization of the connection resistance in the circuit board.

[0052]

Further, since the protective agent 6 exists in the regions not participated in the electrical connection, it is possible to effectively prevent oxidation and penetration of a water. Moreover, the protective agent 6 such as a material (chromate, silane coupler and the like) can be used to enhance the adhesion strength between the wiring layer 2 and the via 3, then to improve the retention stability.

[0053]

[Effects of the Invention]

As it is clear from the above description, in the circuit board according to the present invention, the protective agent is dispersed and placed on an interface between the wiring layer and the via in mottle-like, to thereby for a strong conductive path between the wiring layer and the conductive powders contained in the via, thus resulting in preservation stability for a long term of the connection resistance. Moreover, in such a region that has no protective agent therein, a plurality of the conductive powders contacts the wiring layer to be interconnected therewith electrically, thus further securing the strong connection.

[0054]

Further, metallic adhesion formed between the conductive powders and the wiring layer gives rise to an extremely strong bonding force between the metal atoms because they are extremely close to each other, thus further securing the stability of the connection resistance for a long period.

[0055]

Further, in the region where the protective agent is present, the wiring layer and the via are protected by the protective layer to prevent oxidation and penetration of a water. This contributes to strengthen the conductive path, which in turn improves the electrical connection and the physical adhesion force between the wiring layer and the via, thus it is possible to provide a higher reliability circuit board.

[Brief Description of the Drawings]

[FIG. 1] A cross-sectional view for showing a structure of a circuit board according to a preferred embodiment of the present invention.

[FIG. 2] An imaginary illustration showing a metallic agglutination portion.

[FIG. 3] Illustrations showing an example for manufacturing the circuit board of the embodiment, respectively.

[FIG. 4] Illustrations showing more specifically the circuit board manufacturing method of the embodiment, respectively.

5 [FIG. 5] A figure showing a result of measuring characteristics of the circuit board of the embodiment.

[FIG. 6] A figure showing a result of measuring characteristics of a circuit board of an comparative example.

10 [FIG. 7] A figure showing a result of measuring characteristics of a circuit board of another comparative example.

[Description of Symbols]

1 Insulator layer 2 Wiring layer

2a Via abutting surface 3 Via 4 Conductive powder

5 Metallic agglutination portion 6 Protective agent

15 7 Region (protective agent does not exist)

8 Through hole 9 Conductive paste

10 Conductor foil 10a Adhesion surface

11 Minute pit 12 Minute protrusion

12a Top portion

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[Document Name] Abstract

[Abstract]

[Object] To stabilize the connection resistance for a prolonged period of time.

[Solution] A protective agent 6 for protecting a wiring 1 is dispersed and placed in mottle-like on an interface between a via 3 and a wiring layer 2. Then, each dimension of interface regions 7 where the protective agent 6 does not exist is set to such a size that a plurality of conductive powders 4, constituting the via 3 can abutted on the wiring layer 2. Therefore, the plurality of conductive powders 4 and the wiring layer 2 are abutted each other in each interface region 7 where the protective agent 6 does not exist to electrically connect.

[Selected Drawing] FIG. 1